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# A red queen under the shell : snails as a new model to study cyto-nuclear conflicts and gynodioecy

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## Résumé

Genetic conflicts are usually considered to act as an inner red queen, generating perpetual arms-race coevolution between genes with divergent evolutionary interests within the genome. Cytoplasmic Male Sterility (CMS) in plants is a classical example of such genetic conflicts : hermaphrodites lose the male function to become female, under the influence of mitochondrial genes, whose fitness depends only on the female function ; among nuclear genes, transmitted by both male and female gametes, suppressors of CMS then evolve, called restorers of male fertility. Numerous models of CMS evolution suggest that such conflicts between cytoplasmic and nuclear genes could fuel rapid, frequency-dependent changes in both CMS and nuclear alleles involved. However, although lots of evidence indirectly support this view, these changes have never been observed. Here we relate the discovery of the first animal example of CMS, in the freshwater snail *Physa acuta*. In several respects this system extends to animals many features of known plant systems such as the coexistence of several CMS mitochondrial types, and the presence of polymorphic specific restorers in the nuclear genome. However, the snail system also presents original features such as an exceptional acceleration of mitogenome evolution, resulting in degrees of intraspecific divergence unmatched by any animal or plant we know of. Finally, the short generation time of this small snail allows us to use experimental evolution. This way we can test, for the first time, the theoretical foundations of CMS evolution by directly observing evolutionary dynamics in time. Although this approach is only starting, our first results validate the idea of rapid frequency-dependent dynamics predicted by the models and recall the -very few- other examples of experimental evolution of genetic conflicts such as the *sex-ratio* sex-chromosome drive system in *Drosophila*.

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**Mots-Clés:** genetic conflict, gynodioecy, mating systems, hermaphroditism, mitochondrial genome, freshwater snail, rapid evolution, experimental evolution